

People who undergo revision arthroplasty report more limitations but no decrease in physical activity compared with primary total hip arthroplasty: an observational study

Martin Stevens, Tsjerk Hoekstra, Robert Wagenmakers, Sjoerd K Bulstra and Inge van den Akker-Scheek

University Medical Center Groningen, The Netherlands

Question: Do people who have had revision arthroplasty report more limitations and less physical activity than those after primary total hip arthroplasty? Can degree of limitation and physical activity be predicted by revision arthroplasty, after adjustment for age, gender, and Charnley classification? **Design:** Cross-sectional observational study. **Participants:** 371 people after primary and 134 after revision total hip arthroplasty. **Outcome measures:** Limitations were measured using the Dutch-language version of the WOMAC questionnaire and amount and intensity of physical activity was measured using the SQUASH questionnaire. **Results:** The revision arthroplasty group reported 12% (95% CI 7 to 17) more limitations than the primary total hip arthroplasty group. They also reported 394 min/wk (95% CI 88 to 701) less physical activity and 1153 min/wk (95% CI 66 to 2241) less intensity of physical activity than the primary total hip arthroplasty group. Having had a revision arthroplasty predicted limitations regardless of whether the prediction was adjusted for age, gender, or Charnley group (B −12.1, 95% CI −17.2 to −7.0). However, having had a revision arthroplasty did not predict either amount (B −121.2, 95% CI −408.0 to 165.7) or intensity (B −912.8, 95% CI −1989.1 to 163.6) of physical activity when the prediction was adjusted for age, gender, and Charnley group. **Conclusion:** People reported more limitations after revision arthroplasty than after primary total hip arthroplasty. However, people after revision arthroplasty appeared to be equally physically active as those after primary total hip arthroplasty after adjusting for age, gender, and Charnley group. [Stevens M, Hoekstra T, Wagenmakers R, Bulstra SK, van den Akker-Scheek I (2009) People who undergo revision arthroplasty report more limitations but no decrease in physical activity compared with primary total hip arthroplasty: an observational study. *Australian Journal of Physiotherapy* 55: 185–189]

Key words: Total hip arthroplasty, Revision surgery, Physical activity, Rehabilitation outcome

Introduction

Western society is facing a sharp increase in the number of older adults. In the United States of America, the number of inhabitants aged over 60 is projected to rise from 49 850 000 in 2005 (17% of the population) to 107 741 000 (27%) by 2050, and in the Netherlands from 3 146 000 (19% of the population) to 5 291 000 (31%) (United Nations 2006). This development will be accompanied by an increase in the occurrence of age-related chronic conditions such as osteoarthritis. Since osteoarthritis is the most common reason for total hip arthroplasty, an increase in the demand for total hip arthroplasties can be expected (Kurtz et al 2007).

Although total hip arthroplasty is considered one of the most successful arthroplasties, with prosthetic survival rates at 10 years exceeding 90%, late failure remains a problem that can result in revision arthroplasty (Clohisy et al 2004). The outcome after revision arthroplasty is associated with smaller improvements in physical functioning and lower satisfaction compared to primary total hip arthroplasty (Lübbecke et al 2007). The revision burden, defined as the ratio of revision to the sum of revision arthroplasties and primary total hip arthroplasties, was estimated at 18% between 1990 and 2002 in the USA. In other Western countries, the revision burden has been estimated as between 6% and 18% (Kurtz et al 2005). In the Netherlands, 1500–1600 revision arthroplasties were performed in 2002,

and the expectation is that the number of revisions will increase as the population ages and more primary total hip arthroplasties are performed. In the USA, revision arthroplasties are projected to grow by 137% between 2005 and 2030 (Kurtz et al 2007).

Until now, orthopaedic surgeons, physiotherapists, and other professionals involved in care after total hip arthroplasty use physician- or therapist-based instruments (eg, Harris Hip Score), self-report disease-specific instruments (eg, Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC]) and self-report generic instruments (eg, Short Form-36) to determine outcomes. These instruments mainly provide information about the limitations people experience, but not about the level of physical activity. Moreover, the correlation between limitations measured using disease-specific instruments like the WOMAC and physical activity in people after primary total hip arthroplasty is low (Wagenmakers et al 2008). Therefore, it can be argued that both limitations and physical activity should be measured to obtain a more complete insight into recovery.

Research into limitations and physical activity after revision hip arthroplasty is sparse (Saleh et al 2003). To our knowledge, no study has been conducted so far that compares revision arthroplasty with primary total hip arthroplasty postoperatively in terms of these two different outcomes. We hypothesised that revision arthroplasty will

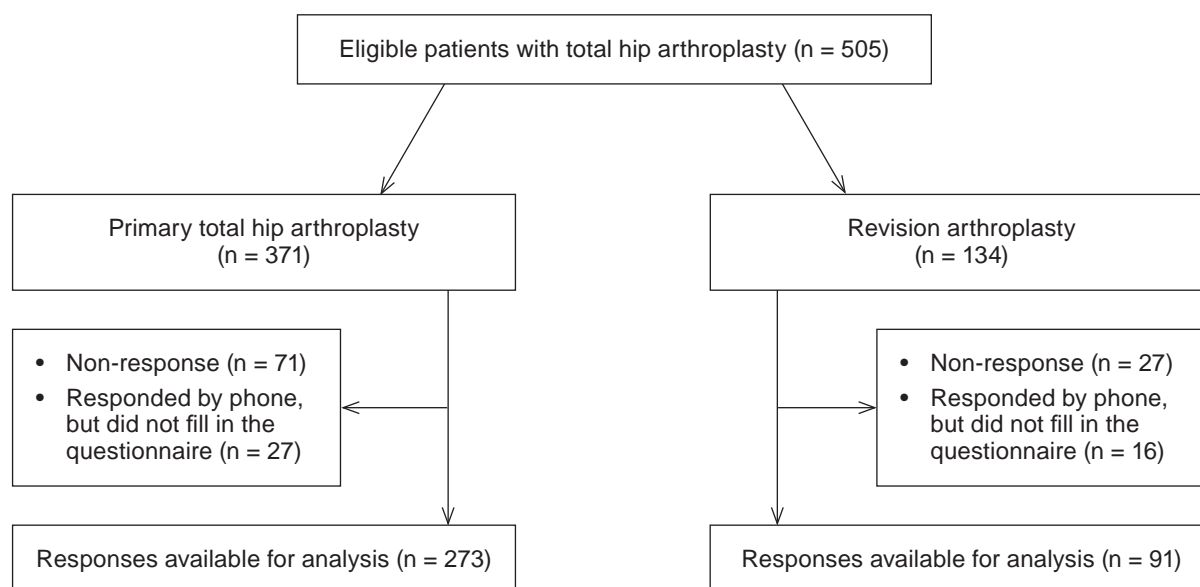


Figure 1. Flow of participants through the study.

not only lead to more limitations compared with primary total hip arthroplasty, but also to a lower level of physical activity. Therefore, the research questions of this study were:

1. Do people who have had revision arthroplasty report more limitations and less physical activity than those after primary total hip arthroplasty?
2. Can degree of limitation and physical activity be predicted by revision hip arthroplasty, after adjustment for age, gender and Charnley classification?

Method

Design

A cross-sectional, observational study was undertaken on a retrospective cohort. All individuals who had undergone primary total hip arthroplasty or revision arthroplasty at the University Medical Center Groningen between February 1998 and October 2003 were sent an explanatory letter and a questionnaire in October 2004, ie, at least a year after the operation. If the participant did not respond, a reminder was sent after three weeks.

Participants

Patients were included if they had undergone primary total hip arthroplasty or revision arthroplasty. There were no exclusion criteria except death at the time of follow-up. Demographic characteristics (age, gender) were collected from the questionnaire. Co-morbidity was collected from the medical records using the Charnley classification (Charnley 1972).

Outcome measures

Limitations were measured using the Dutch-language version of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (Bellamy et al 1988, Roorda et al 2004). The WOMAC is a widely-used, disease-specific, health-related quality of life questionnaire for measuring outcome after total hip arthroplasty (McConnell et al 2001). Using a Likert scale, individuals rate themselves on multiple items grouped into three domains: pain (5 items), stiffness (2 items), and physical functioning (17 items). The scores of the subscales make up the total score. In this study, the

total score was converted to a 100-point scale, with a higher score representing fewer limitations.

Physical activity was measured using the self-report Short QUestionnaire to ASsess Health-enhancing physical activity (SQUASH) which is a valid and reliable questionnaire for measuring physical activity in adults (Wendel-Vos et al 2003) and older adults after primary total hip arthroplasty (Wagenmakers et al 2008). The questions are grouped into activities at work, activities to/from work, household activities, leisure-time activities, and sports activities. With the help of the Ainsworth compendium of physical activities, three intensity categories are used to subdivide activities for adults aged 55 or older: light is 2 to 3 MET (ie, metabolic equivalents of task), moderate is 3 to 5 MET, and 5 MET or more is vigorous (Ainsworth et al 1993). Activities with a MET value lower than 2 are not included because they are considered to contribute negligibly to habitual activity level. In this study, the outcome was calculated in two ways. Amount of each activity was calculated by multiplying frequency (days/week) by duration (min/day), and then summed to produce total amount of physical activity (min/wk). Each activity was assigned an intensity score which was multiplied by frequency (days/wk) and duration based on the reported effort (min/day), and then summed to produce total intensity of physical activity (min/wk).

Data analysis

Characteristics of the participants and outcome measures are presented as mean (SD) or number (%) for each group and difference between the groups as mean difference or odds ratios (95% CI). Multiple linear regression analysis (ENTER method) was used to determine whether limitations determined from the WOMAC could be predicted from having primary or revision arthroplasty (coded 0 and 1 respectively) and adjusted *a priori* for age (years), gender (male 0, female 1), and Charnley classification (Group A 0, Group B or C 1). Next, the same analyses were conducted for total amount of physical activity a week and the total intensity of physical activity as determined with the SQUASH. A *p* value < 0.05 was considered to be statistically significant.

Table 1. Mean (SD) or n (%) of baseline characteristics for each group and mean difference or odds ratios (95% CI) between groups.

Characteristic	Groups		Difference between groups
	Revision THA (n = 91)	Primary THA (n = 273)	Revision minus primary
Gender, n female (%)	61 (67)	166 (61)	OR 1.3 (0.8 to 2.2)
Age (yr), mean (SD)	70 (12)	63 (14)	MD 7 (4 to 10)
Time since surgery (mth), mean (SD)	39 (19)	39 (15)	MD 1 (–3 to 4)
Co-morbidity			
Charnley Group A, n (%)	61 (67)	193 (71)	OR 0.8 (0.5 to 1.4)
Charnley Group B, n (%)	20 (22)	56 (21)	OR 1.1 (0.6 to 1.9)
Charnley Group C, n (%)	10 (11)	24 (9)	OR 1.3 (0.6 to 2.8)

Charnley Group A = involvement of only one hip and no other condition interfering with physical activity; Charnley Group B = involvement of both hips but the rest of the body normal, therefore ability to be physically active; Charnley Group C = some condition, such as rheumatoid arthritis or hemiplegia, contributing to failure to achieve normal locomotion; THA = total hip arthroplasty.

Table 2. Mean (SD) outcome for each group and mean difference (95% CI) between groups.

Outcome	Groups		Difference between groups
	Revision THA (n = 63 to 89)	Primary THA (n = 224 to 271)	Revision minus primary
Limitations – WOMAC (0 to 100)			
Pain	70 (25)	81 (20)	–11 (–17 to –6)
Stiffness	61 (21)	70 (22)	–10 (–15 to –4)
Physical functioning	59 (25)	72 (22)	–13 (–19 to –8)
Total limitations	63 (24)	74 (20)	–12 (–17 to –7)
Physical activity – SQUASH (min/wk)			
Light household	679 (773)	619 (765)	60 (–129 to 248)
Intense household	31 (94)	43 (161)	–12 (–48 to 24)
Commuter walking/cycling	9 (50)	29 (116)	–20 (–44 to 6)
Sports	75 (139)	60 (60)	15 (–21 to 53)
Leisure-time	581 (599)	671 (709)	–90 (–280 to 101)
Work and school	130 (455)	384 (778)	–254 (–426 to –82)
Total amount of physical activity*	1219 (1118)	1613 (1324)	–394 (–701 to –88)
Total intensity of physical activity (min/wk)	2585 (3658)	3738 (4775)	–1153 (–2241 to –66)

* = total value is not the sum of the values above as a result of the variation of n

Results

Flow of participants through the study

Of the included participants with a primary (n = 371) or revision total hip arthroplasty (n = 134), 273 (74%) participants with a primary and 91 (68%) with a revision total hip arthroplasty returned the questionnaire. Twenty-seven (7%) participants after primary total hip arthroplasty and 16 (12%) after revision arthroplasty responded by phone or mail but did not fill in the questionnaire, and 71 (19%) participants after primary and 27 (21%) participants after revision arthroplasty did not respond at all (Figure 1). Non-responders were no different in terms of age, gender, and Charnley classification from responders.

Baseline characteristics are shown in Table 1. Mean age in the primary total hip arthroplasty group was 63 years, and 61% were female. The revision arthroplasty group was on average 7 years (95% CI 4 to 10) older than the primary total hip arthroplasty group; 67% were female. About two-thirds of the participants were classified as Charnley Group

A. There was no difference in mean time since arthroplasty between the two groups.

Limitations and physical activity

Limitations and physical activity for each group and the difference between groups are presented in Table 2. The revision arthroplasty group reported 12% (95% CI 7 to 17) more limitations than the primary total hip arthroplasty group. There was a lower score for each category (pain, stiffness, physical functioning) for the revision arthroplasty group. The revision arthroplasty group reported 394 min/wk (95% CI 88 to 701) less physical activity in total and 1153 min/wk (95% CI 66 to 2241) less intensity of physical activity in total than the primary total hip arthroplasty group. However, there were no significant differences for household activities, commuter walking/cycling, sports, or leisure-time activities.

Prediction of limitations and physical activity

Linear regression analysis was performed to determine whether limitations were predicted by revision hip arthroplasty. The regression coefficient for being in the revision group was -12.1 (95% CI -17.1 to -7.0). This was the same as the regression coefficient for being in the revision group of -12.1 (95% CI -17.2 to -7.1) when age, gender, and Charnley group were added to the prediction equation, suggesting that these additional predictors did not confound the relation between group and limitation (Box 1). Revision group, age, gender, and Charnley group accounted for 9% of the variance in limitations.

Box 1. Mean (95% CI) regression coefficients of predictors and prediction equation from the multivariate analysis and accuracy of prediction for limitations determined from total WOMAC score ($n = 361$).

Regression coefficients of predictors

Constant = 83.66 (72.45 to 94.86)
 Revision group = -12.13 (-17.22 to -7.05)
 Age = 0.99 (-0.65 to 0.26)
 Female gender = -4.14 (-8.67 to 0.39)
 Charnley Group B = 0.37 (-4.96 to 5.69)
 Charnley Group C = -12.54 (-20.05 to -5.02)

Prediction equation

Limitations = 84
 $- 12.1$ revision group (1)
 $+ 1.0$ age (yr)
 $- 4.1$ female gender (1)
 $+ 0.4$ Charnley Group B (1)
 $- 12.5$ Charnley Group C (1)

Accuracy of prediction equation

$R^2 = 0.09$

Linear regression analysis was also performed to determine whether total amount of physical activity was predicted by revision hip arthroplasty. The regression coefficient for being in the revision group was -394.3 (95% CI -701.1 to -87.5). The regression coefficient for being in the revision group of -121.2 (95% CI -408.0 to 165.7) was no longer significant when age, gender, and Charnley group were added to the prediction equation, suggesting that these additional predictors did not confound the relation between group and limitation (Box 2). Revision group, age, gender, and Charnley group accounted for 18% of the variance in total amount of physical activity.

Finally, linear regression analysis was performed to determine whether total intensity of physical activity was predicted by revision hip arthroplasty. The regression coefficient for being in the revision group was -1153.7 (95% CI -2241.1 to -66.3). The regression coefficient for being in the revision group of -912.8 (95% CI -1989.1 to 163.6) was no longer significant when age, gender, and Charnley group were added to the prediction equation, suggesting that these additional predictors did not confound the relation between group and limitation (Box 3). Revision group, age, gender and Charnley group accounted for 9% of the variance in total intensity of physical activity.

Box 2. Mean (95% CI) regression coefficients of predictors and prediction equation from the multivariate analysis and accuracy of prediction for total amount of physical activity determined from SQUASH ($n = 361$).

Regression coefficients of predictors

Constant = 4166.11 (3535.77 to 4796.45)
 Revision group = -121.16 (-408.03 to 165.70)
 Age = -37.53 (-46.75 to -28.31)
 Female gender = -60.13 (-315.81 to 195.55)
 Charnley Group B = -32.91 (-335.88 to 270.07)
 Charnley Group C = -413.81 (-837.14 to 9.53)

Prediction equation

Total amount of physical activity
 = 4166
 $- 121$ revision group (1)
 $- 38$ age (yr)
 $- 60$ female gender (1)
 $- 33$ Charnley Group B (1)
 $- 414$ Charnley Group C (1)

Accuracy of prediction equation

$R^2 = 0.18$

Box 3. Mean (95% CI) regression coefficients of predictors and prediction equation from the multivariate analysis and accuracy of prediction for total intensity of physical activity determined from SQUASH ($n = 361$).

Regression coefficients of predictors

Constant = 6645.44 (4280.34 to 9010.53)
 Revision group = -912.76 (-1989.11 to 163.58)
 Age = -4.81 (-39.40 to 29.78)
 Female gender = -2412.23 (-3371.57 to -1452.90)
 Charnley Group B = -586.73 (-1723.51 to 550.05)
 Charnley Group C = -1089.25 (-2677.84 to 499.15)

Prediction equation

Total intensity of physical activity
 = 6645
 $- 913$ revision group (1)
 $- 5$ age (yr)
 $- 2412$ female gender (1)
 $- 587$ Charnley Group B (1)
 $- 1089$ Charnley Group C (1)

Accuracy of prediction equation

$R^2 = 0.08$

Discussion

From this cross-sectional study it can be concluded that although people report more limitations (total WOMAC score) after revision arthroplasty than after primary arthroplasty, this does not result in a significant decrease in physical activity. Although people with a revision arthroplasty reported less total physical activity than those with a primary total hip arthroplasty, to a large extent caused by 'activity at work and school', adjusting for age, gender, and Charnley group resulted in a difference that was not significant.

Information about outcome after revision arthroplasty is sparse (Saleh et al 2003), and to our knowledge no research has been conducted into physical activity behaviour after revision arthroplasty. Most studies measure outcome using self-report questionnaires such as the WOMAC. The WOMAC measures perceived limitations in performing ADL activities, yet experiencing limitations may not be the same as executing physical activities. A previous study indicated that revision arthroplasty is associated with smaller improvements and less satisfaction compared with primary total hip arthroplasty (Lübbecke et al 2007). Our results, though obtained using a cross-sectional design, appear to support this notion. From the results on the WOMAC it can be concluded that having a revision or a primary total hip arthroplasty results in more limitations. After revision arthroplasty, people scored 12 points worse on the WOMAC than after primary arthroplasty. This can be considered not only statistically-significant but also clinically-significant (Angst et al 2001). On the other hand, when it comes to physical activity, revision arthroplasty does not affect physical activity when adjusted for age, gender, and Charnley group.

There are some limitations to this study. First, the data were gathered retrospectively. For example, Charnley classification reflects the preoperative status and not the postoperative status at the time the participants filled in the questionnaire. Also, due to the retrospective nature of the study no information was available with respect to other aspects of co-morbidity (eg, cardiovascular and respiratory diseases). Moreover, this retrospectivity may also have reduced the accuracy of scoring the Charnley classification from the medical record. Second, the SQUASH is a self-report instrument. A disadvantage of self-report instruments is that, in general, people tend to overestimate their physical activity (Sallis and Saelens 2000). An alternative is to use objective outcome measures like step counters or accelerometers, although they are more expensive and logistically more difficult to administer on a large scale. However, it would be interesting to see if the results of this study could be replicated with such an objective measure.

Insight into the recovery of people after revision arthroplasty is a relevant topic as societies age, and becomes even more important with the current trend of primary total hip arthroplasties being performed on people at an ever-younger age. This trend will eventually lead to an increase in revision arthroplasties (Kurtz et al 2007). The findings of this study suggest that after revision arthroplasty people have more limitations than those after primary total hip arthroplasty but are equally physically active after adjusting for age, gender, and Charnley group. ■

Ethics: The Medical Ethics Board of University Medical Center Groningen judged this study to be 'not medical research' under the Medical Research Involving Human Subjects Act (in Dutch WMO). Informed consent was considered to be gained when participants returned the questionnaire.

Competing interests: None declared.

Correspondence: Martin Stevens, University Medical Center Groningen, PO Box 30001, 9700 RB Groningen, The Netherlands. Email: m.stevens@orth.umcg.nl

References

- Ainsworth BE, Haskell WL, Leon AS, Jacobs DR Jr, Montoye HJ, Sallis JF, Paffenbarger RS Jr (1993) Compendium of physical activities: classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise* 25: 71–80.
- Angst F, Aeschlimann A, Stucki G (2001) Smallest detectable and minimal clinically important differences of rehabilitation intervention with their implications for required sample sizes using WOMAC and SF-36 quality of life measurement instruments in patients with osteoarthritis of the lower extremities. *Arthritis and Rheumatism* 45: 384–391.
- Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt L (1988) Validation study of WOMAC: a health status instrument for measuring clinically-important patient-relevant outcomes following total hip or knee arthroplasty in osteoarthritis. *Journal of Rheumatology* 1: 95–108.
- Charnley J (1972) The long-term results of low-friction arthroplasty of the hip performed as a primary intervention. *Journal of Bone and Joint Surgery* 54B: 61–76.
- Clohisey JC, Calvert G, Tull F, McDonald D, Maloney WJ (2004) Reasons for revision hip surgery. *Clinical Orthopaedics and Related Research* 429: 188–192.
- Lübbecke A, Katz JN, Perneger TV, Hoffmeyer P (2007) Primary and revision hip arthroplasty: 5-year outcomes and influence of age and comorbidity. *Journal of Rheumatology* 34: 394–400.
- Kurtz S, Ong K, Lau E, Mowat F, Halpern M (2007) Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *Journal of Bone and Joint Surgery* 89A: 780–785.
- Kurtz S, Mowat F, Ong K, Chan N, Lau E, Halpern M (2005) Prevalence of primary and revision total hip and knee arthroplasty in the United States from 1990 through 2002. *Journal of Bone and Joint Surgery* 87A: 1487–1497.
- McConnell S, Kolopack P, Davis AM (2001) The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): a review of its utility and measurement properties. *Arthritis Care and Research* 45: 453–461.
- Roorda LD, Jones CA, Waltz M, Lankhorst GJ, Bouter LM, Eijken van der JW, Willems WJ, Heyligers IC, Voaklander DC, Kelly KD, Suarez-Almazor ME (2004) Satisfactory cross cultural equivalence of the Dutch WOMAC in patients with hip osteoarthritis waiting for arthroplasty. *Annals of the Rheumatic Diseases* 73: 36–42.
- Saleh KJ, Celebrezze M, Kassim R, Dykes DC, Gioe TJ, Callaghan JJ, Salvati EA (2003) Functional outcome after revision hip arthroplasty: a metaanalysis. *Clinical Orthopaedics and Related Research* 416: 254–264.
- Sallis JF, Saelens BE (2000) Assessment of physical activity by self-report: status, limitations, and future directions. *Research Quarterly for Exercise and Sport* 71: 1.
- Wagenmakers R, van den Akker-Scheek I, Groothoff JW, Zijlstra W, Bulstra SK, Kootstra JWJ, Wendel-Vos GCW, van Raaij JJAM, Stevens M (2008) Reliability and validity of the Short Questionnaire to Assess Health-enhancing physical activity (SQUASH) in patients after total hip arthroplasty. *BMC Musculoskeletal Disorders* 17: 141.
- Wagenmakers R, Stevens M, van den Akker-Scheek I, Groothoff JW (2008) Predictive value of the Western Ontario and McMaster Universities Osteoarthritis Index for the amount of physical activity after total hip arthroplasty. *Physical Therapy* 88: 211–218.
- Wendel-Vos W GC, Schuit JA, Saris WHM, Kromhout D (2003) Reproducibility and relative validity of the short questionnaire to assess health-enhancing physical activity. *Journal of Clinical Epidemiology* 56: 1163–1169.

Website

United Nations (2006) World population prospects (2006 revision) and World urbanization prospects (2005 revision). <http://esa.un.org/unpp/> [Accessed September 6, 2008].